CHAPTER  8 | ROTATIONAL KINEMATICS

19. **REASONING AND SOLUTION**
   a. Since the flywheel comes to rest, its final angular velocity is zero. Furthermore, if the initial angular velocity $\omega_0$ is assumed to be a positive number and the flywheel decelerates, the angular acceleration must be a negative number. Solving Equation 8.8 for $\theta$, we obtain
   \[ \theta = \frac{\omega^2 - \omega_0^2}{2\alpha} = \frac{(0 \text{ rad/s})^2 - (220 \text{ rad/s})^2}{2(-2.0 \text{ rad/s}^2)} = 1.2 \times 10^4 \text{ rad} \]
   
   b. The time required for the flywheel to come to rest can be found from Equation 8.4. Solving for $t$, we obtain
   \[ t = \frac{\omega - \omega_0}{\alpha} = \frac{0 \text{ rad/s} - 220 \text{ rad/s}}{-2.0 \text{ rad/s}^2} = 1.1 \times 10^2 \text{ s} \]

27. **REASONING**  The angular displacement of the child when he catches the horse is, from Equation 8.2, $\theta_c = \omega_c t$. In the same time, the angular displacement of the horse is, from Equation 8.7 with $\omega_0 = 0 \text{ rad/s}$, $\theta_h = \frac{1}{2} \alpha t^2$. If the child is to catch the horse $\theta_c = \theta_h + \left(\frac{\pi}{2}\right)$.

   **SOLUTION**  Using the above conditions yields
   \[ \frac{1}{2} \alpha t^2 - \omega_c t + \frac{\pi}{2} = 0 \]
   or (suppressing the units)
   \[ \frac{1}{2} (0.0100) t^2 - 0.250 t + \frac{\pi}{2} = 0 \]
   The quadratic formula yields $t = 7.37 \text{ s}$ and $42.6 \text{ s}$; therefore, the shortest time needed to catch the horse is $t = 7.37 \text{ s}$.

47. **REASONING AND SOLUTION**  From Equation 2.4, the linear acceleration of the motorcycle is
   \[ a = \frac{v - v_0}{t} = \frac{22.0 \text{ m/s} - 0 \text{ m/s}}{9.00 \text{ s}} = 2.44 \text{ m/s}^2 \]
Since the tire rolls without slipping, the linear acceleration equals the tangential acceleration of a point on the outer edge of the tire: \( a = a_T \). Solving Equation 8.13 for \( \alpha \) gives

\[
\alpha = \frac{a_T}{r} = \frac{2.44 \text{ m/s}^2}{0.280 \text{ m}} = 8.71 \text{ rad/s}^2
\]

51. **REASONING** Assuming that the belt does not slip on the platter or the shaft pulley, the tangential speed of points on the platter and shaft pulley must be equal; therefore, \( r_s \omega_s = r_p \omega_p \).

**SOLUTION** Solving the above expression for \( \omega_s \) gives

\[
\omega_s = \frac{r_p \omega_p}{r_s} = \frac{(3.49 \text{ rad/s})(0.102 \text{ m})}{1.27 \times 10^{-2} \text{ m}} = 28.0 \text{ rad/s}
\]